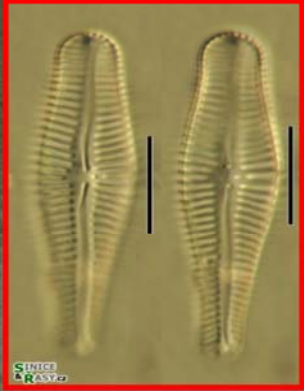




Protista

PREPARED

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Major differences among kingdoms in the Five Kingdom System of Classification of Robert Whittaker :

Property	Monera	Protista	Fungi	Plantae	Animalia
Cell type	prokaryotic	eukaryotic	eukaryotic	eukaryotic	eukaryotic
Cell organization	Mostly unicellular	Mostly unicellular	Multicellular and unicellular	Mostly multicellular	Mostly multicellular
Cell wall	present	Somewhat present	present	present	absent
Nutritional class	Phototrophic, heterotrophic or chemoautotrophic	Heterotrophic and phototrophic	Heterotrophic	phototrophic	Heterotrophic
Mode of nutrition	Absorptive	Absorptive or ingestive	Absorptive	Mostly Absorptive	Mostly ingestive
Motility	Motile or non motile	Motile or non motile	Non motile	Mostly non motile	Mostly Motile

Algae

Phylum Chlorophyta—The Green Algae

Phylum Chromophyta

Yellow-Green Algae (Xanthophyceae)

Golden-Brown Algae (Chrysophyceae)

Diatoms (Bacillariophyceae)

Brown Algae (Phaeophyceae)

Phylum Rhodophyta—The Red Algae

Phylum Euglenophyta—The Euglenoids

Phylum Dinophyta—The Dinoflagellates

Phylum Cryptophyta—The Cryptomonads

Phylum Prymnesiophyta (Haptophyta)

Phylum Charophyta—The Stoneworts

Other Members of Kingdom Protista

Phylum Myxomycota

Phylum Dictyosteliomycota

Phylum Oomycota

Phylum Protozoa

Phylum Porifera

Kingdom: Protista

Classes: Chlorophyceae

Bacillariophyceae

Phaeophyceae

Rhodophyceae

Definition

Algae are photoautotrophic

O₂ producing organisms.

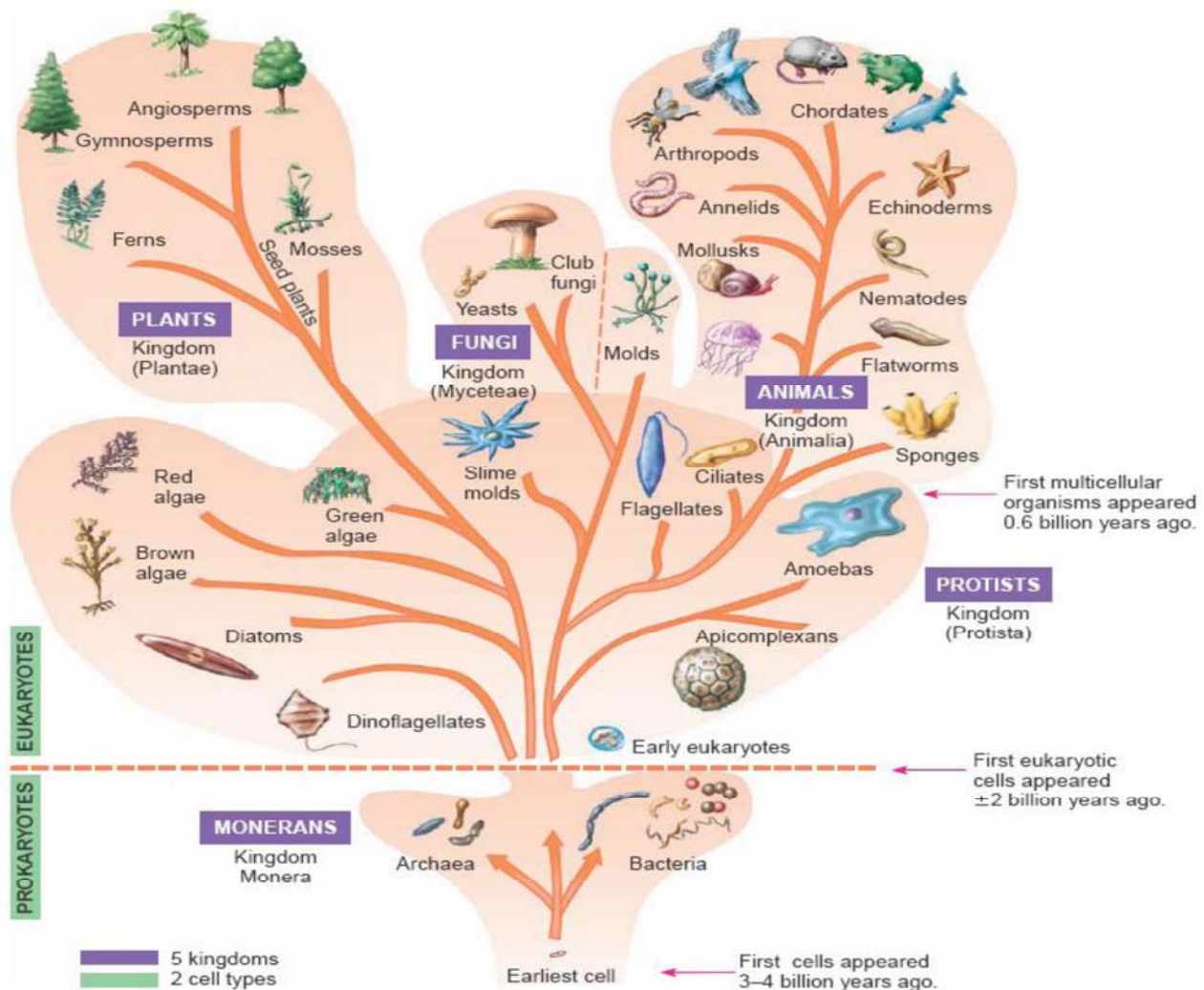


Figure 1.14 Traditional Whittaker system of classification. In this system, kingdoms are based on cell structure and type, the nature of body organization, and nutritional type. Bacteria and Archaea (monerans) have prokaryotic cells and are unicellular. Protists have eukaryotic cells and are mostly unicellular. They can be photosynthetic (algae), or they can feed on other organisms (protozoa). Fungi are eukaryotic cells and are unicellular or multicellular; they have cell walls and are not photosynthetic. Plants have eukaryotic cells, are multicellular, have cell walls, and are photosynthetic. Animals have eukaryotic cells, are multicellular, do not have cell walls, and derive nutrients from other organisms.

Table 12.4 Characteristics of Selected Phyla of Algae						
	Brown Algae	Red Algae	Green Algae	Diatoms	Dinoflagellates	Water Molds
Phylum	Phaeophyta	Rhodophyta	Chlorophyta	Bacillariophyta	Dinoflagellata	Oomycota
Color	Brownish	Reddish	Green	Brownish	Brownish	Colorless, white
Cell Wall	Cellulose and alginic acid	Cellulose	Cellulose	Pectin and silica	Cellulose in membrane	Cellulose
Cell Arrangement	Multicellular	Most are multicellular	Unicellular and multicellular	Unicellular	Unicellular	Multicellular
Photosynthetic Pigments	Chlorophyll <i>a</i> and <i>c</i> , xanthophylls	Chlorophyll <i>a</i> and <i>d</i> , phycobiliproteins	Chlorophyll <i>a</i> and <i>b</i>	Chlorophyll <i>a</i> and <i>c</i> , carotene, xanthophylls	Chlorophyll <i>a</i> and <i>c</i> , carotene, xanthins	None
Sexual Reproduction	Yes	Yes	Yes	Yes	In a few (?)	Yes (similar to the Zygomycota)
Storage Material	Carbohydrate	Glucose polymer	Glucose polymer	Oil	Starch	None

Table 10.5**Diversity of Phototrophic Organisms**

Eucaryotic Organisms	Procaryotic Organisms
Plants	Cyanobacteria
Multicellular green, brown, and red algae	Green sulfur bacteria Green nonsulfur bacteria
Unicellular protists (e.g., euglenoids, dinoflagellates, diatoms)	<i>Halobacterium</i> (archaeon) Purple sulfur bacteria Purple nonsulfur bacteria

Class: Chlorophyceae

General characters

- **The Chlorophyta, or green algae, have chlorophylls a and b as the main photosynthetic pigments.**
- **Reserve material is starch, usually in association with a pyrenoid within the chloroplast.**

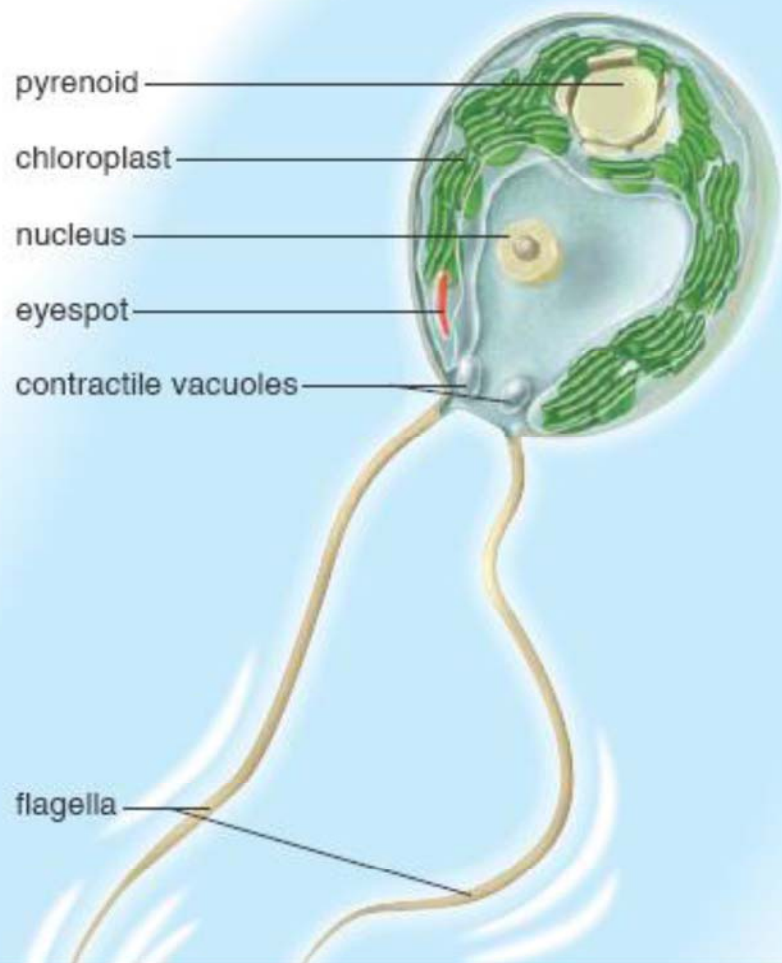
The Chlorophyta thus differ from the rest of the eukaryotic algae in forming the storage product in the chloroplast instead of in the cytoplasm.

- **In Algae the plant body shows no differentiation into root, stem or leaf or true tissues. Such a plant body is called thallus. They do not have vascular tissues.**
- **Occurrence: Other algal habitats include the surface of soil, rocks, and plants; and several species are even hardy enough to live in hot springs or snowbanks.**

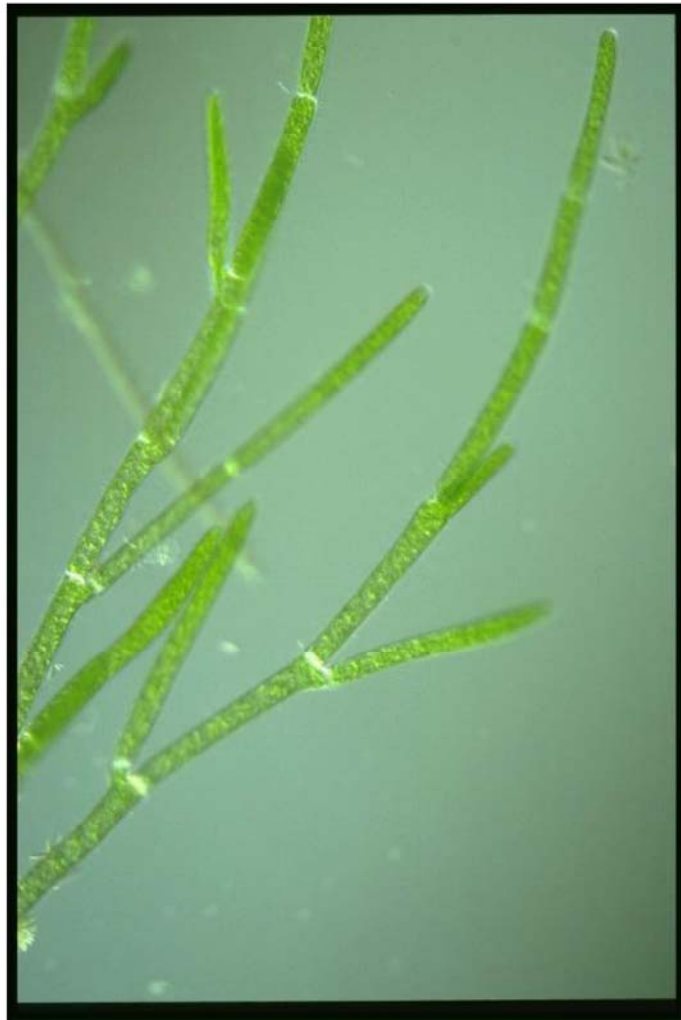
- **The Chlorophyta are primarily freshwater; only about 10% of the algae are marine, whereas 90% are freshwater.**
- **The typical green algal cell, may be motile or non-motile.**
- **Two-layered cellulose and pectin cell wall.**

Vegetative Structure:

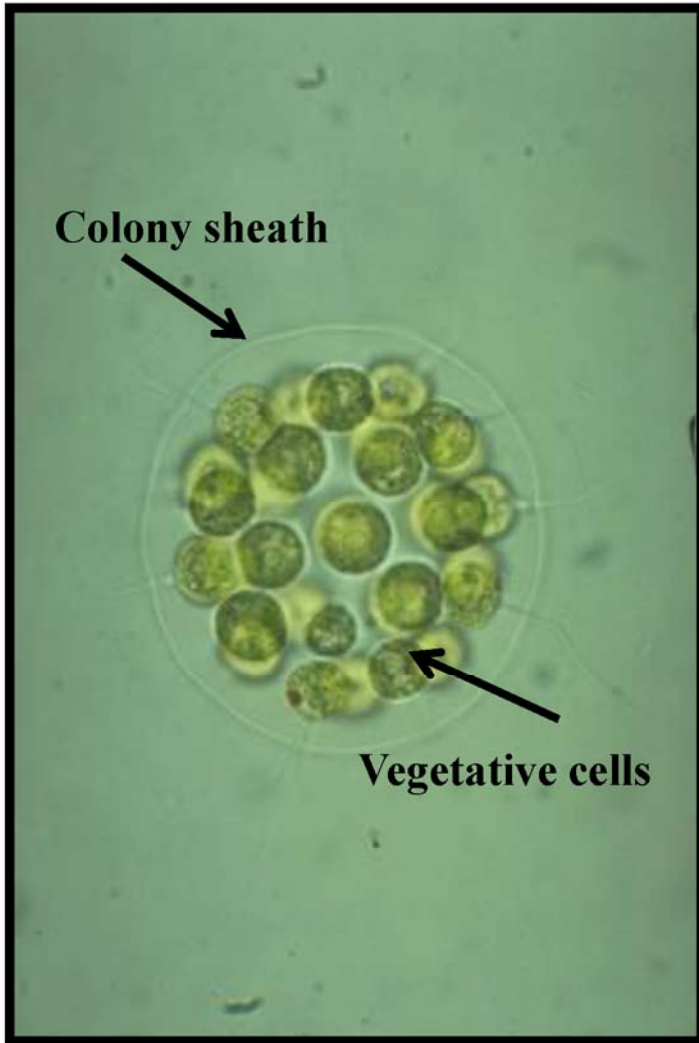
- **Green algae, variable in size and shape, include single celled (*Chlamydomonas*), colonial (*Volvox*), filamentous (*Cladophora*), and tubular (*Enteromorpha*) forms, membranous or sheet-like (*Ulva*).**
- **Some are unicellular and microscopic; in fact, the green alga *Micromonas* is only 1 μ m in diameter—the smallest eukaryotic cell known.**



Unicellular



Filamentous



Colony



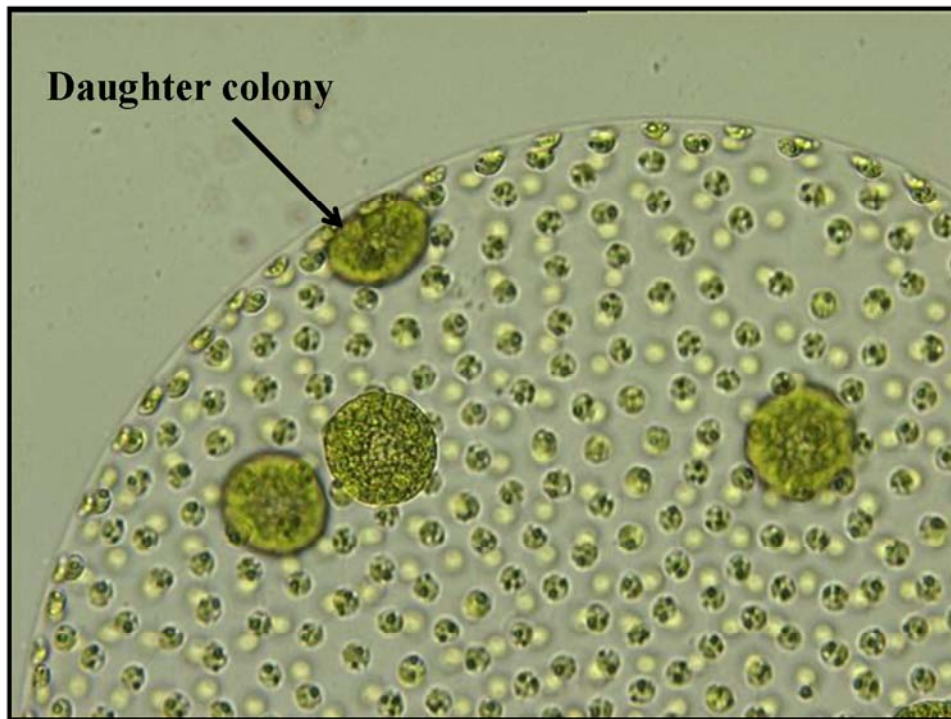
Membranous

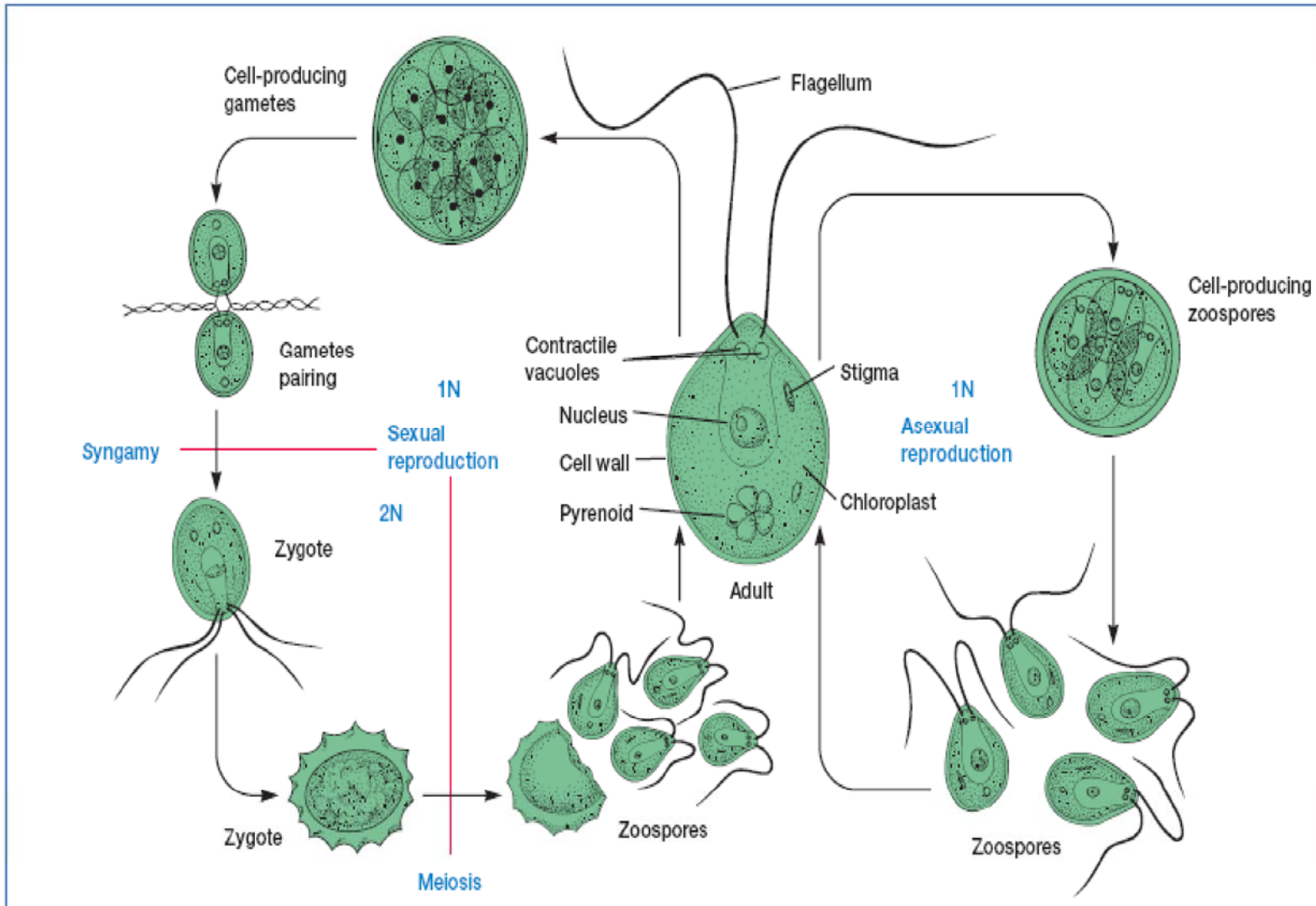


Tubular

- Asexual reproduction is by cell division (*Protococcus*), motile or non-motile spores (*Ulothrix*, *Oedogonium*), gonidia (*Volvox*) and fragmentation.
- Sexual reproduction is common, with gametes that have two or four flagella.

Cell that divides to form a daughter colony (gonidium).





***Chlamydomonas*: The Structure and Life Cycle of This Motile Green Alga. During asexual reproduction, all structures are haploid; during reproduction, only the zygote is diploid.**

Class: Bacillariophyceae

Definition

- **Diatoms** Photosynthetic protists with siliceous cell walls called frustules. They constitute a substantial fraction of the phytoplankton.
- **Frustule** is a silicified cell wall in the diatoms.

General Characters

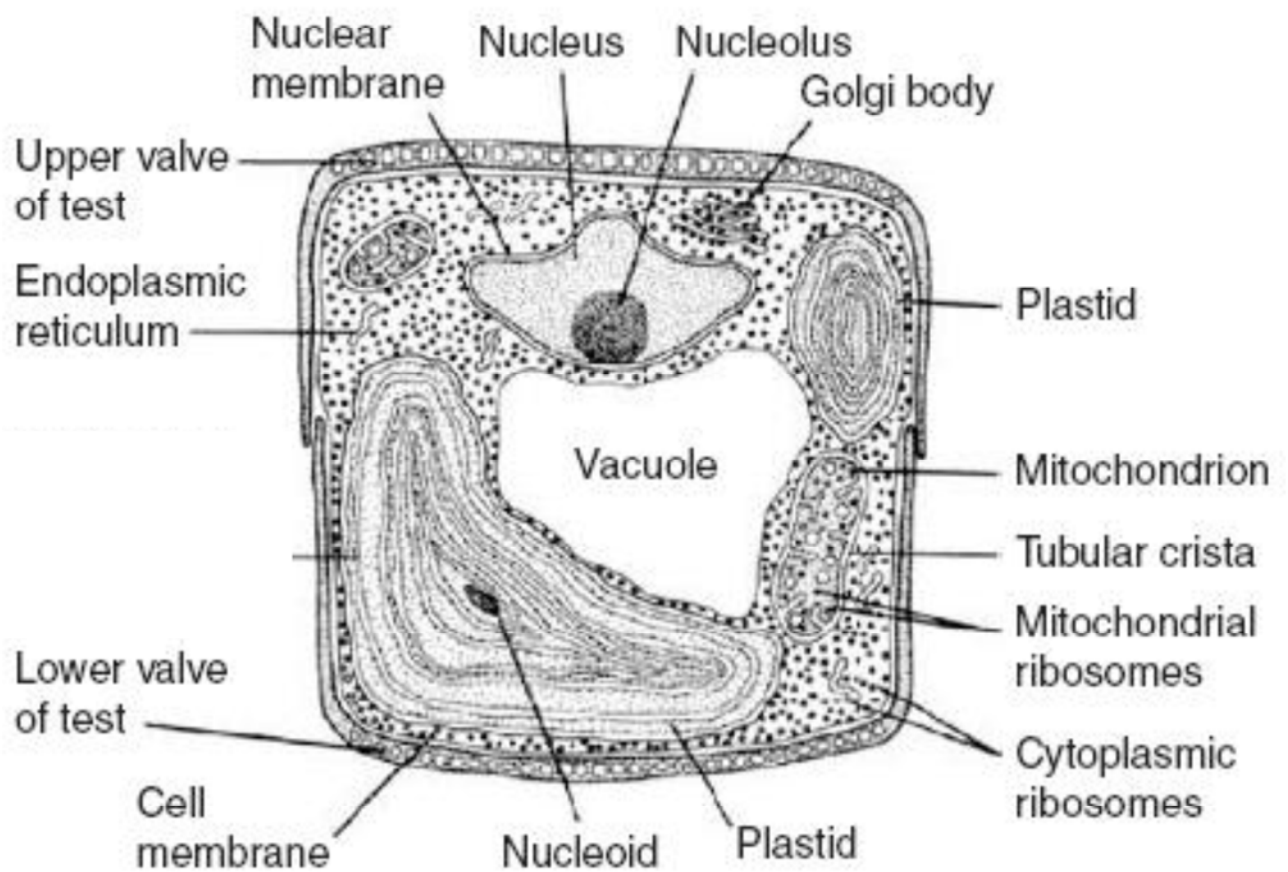
1- Photosynthetic pigments are

- **Principal pigments:** chlorophylls a and c.
- **Accessory pigments:** include carotenoids which may be divided into:

- ❖ **Carotenes** (beta-carotene).
- ❖ **Xanthophylls** (fucoxanthin (golden-brown color) , lutein, and diatoxanthin).

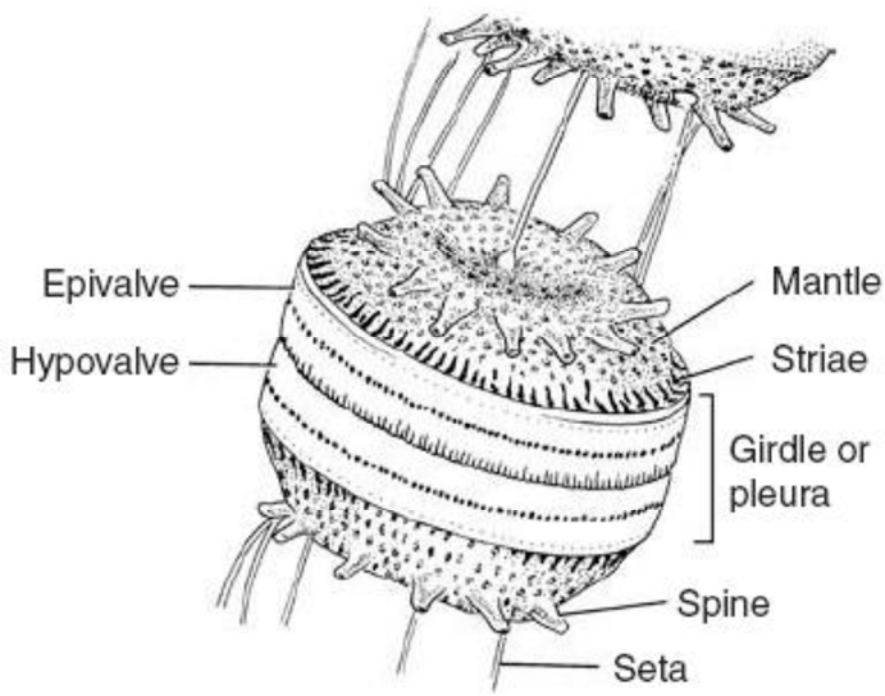
2- Have a single large nucleus.

3-Each diatom may have one, two, or many chloroplasts per cell.

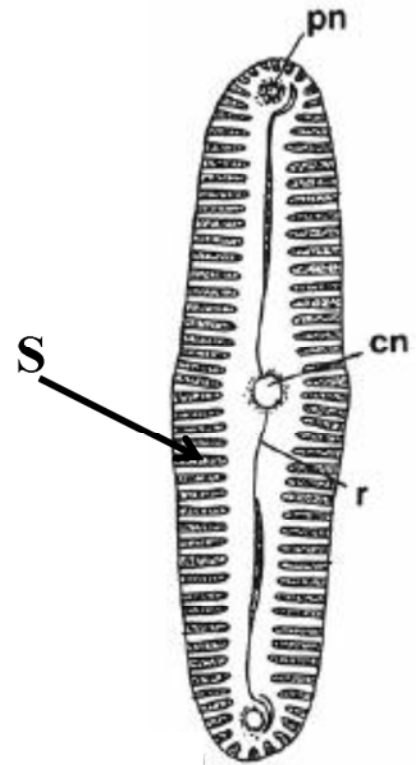


Diatom cell structure

4- Diatom frustules are composed of two halves or thecae that overlap like a petri-dish. The larger half is the epitheca, and the smaller half is the hypotheca.

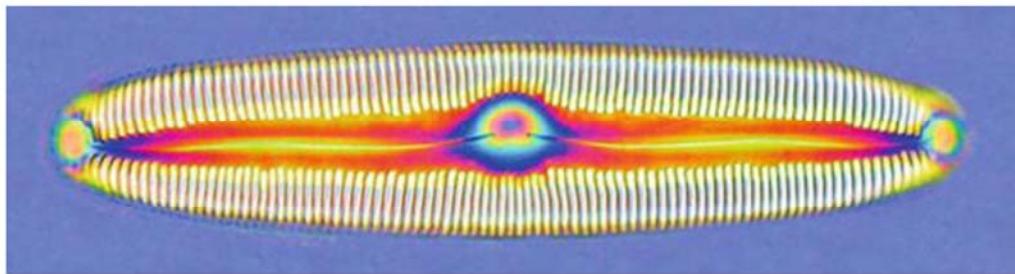
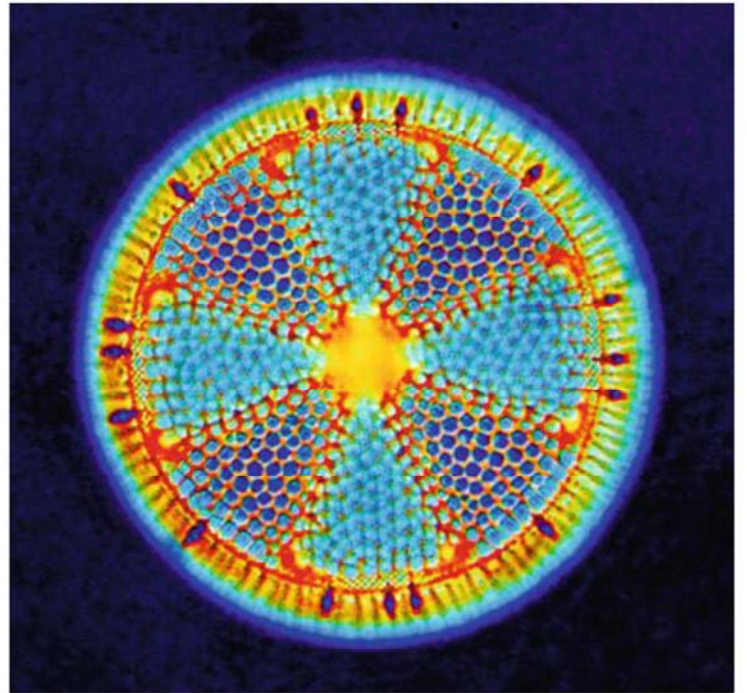


Girdle view



Valve view

Pn: polar nodule, cn: central nodule, r: raphe, s: striae



Different Shapes of Diatoms

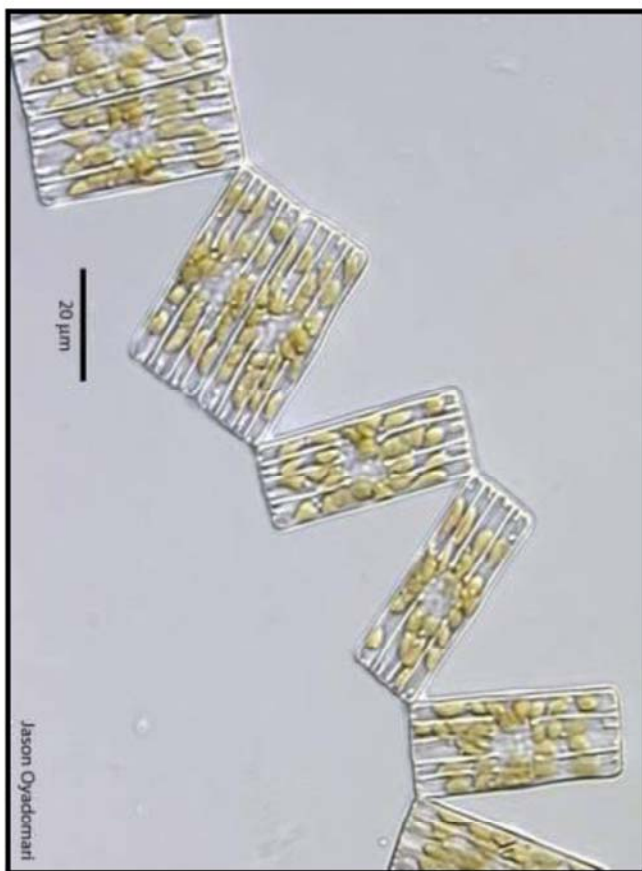
5- Diatom frustules are composed of crystallized silica $[\text{Si}(\text{OH})_4]$ with very fine markings.

6- Although the majority of diatoms are strictly photoautotrophic, some are facultative chemoorganotrophs, absorbing carbon-containing molecules through the holes in their walls.

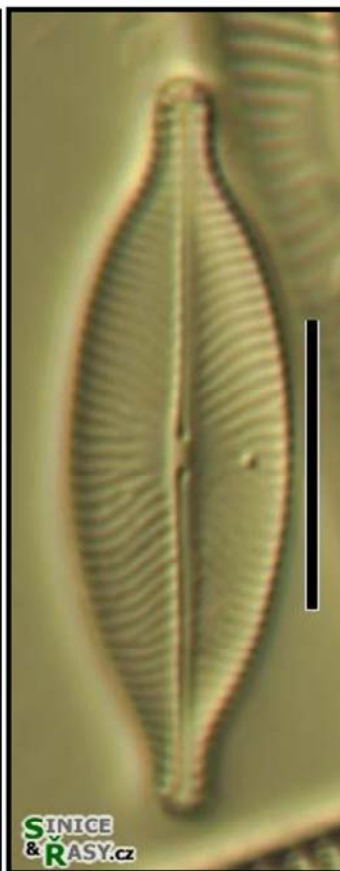
7- Diatoms are found in freshwater lakes, ponds, streams, and throughout the world's oceans.

8- They lack flagella, so, non-motile.

9- Vegetative structure: diatoms are unicellular, colonial, or filamentous.



Colony



Unicellular



Filamentous

10- Some diatoms are able to glide over the surface of a substrate, leaving a mucilaginous trail in their wake.

11-Reproduction of the organism asexually by binary fission and sexually by formation of gametes .

12- Their major reserve material is a carbohydrate known as chrysolaminarin (a polysaccharide storage product composed principally of (1→3) linked glucose residues), oils and fats.

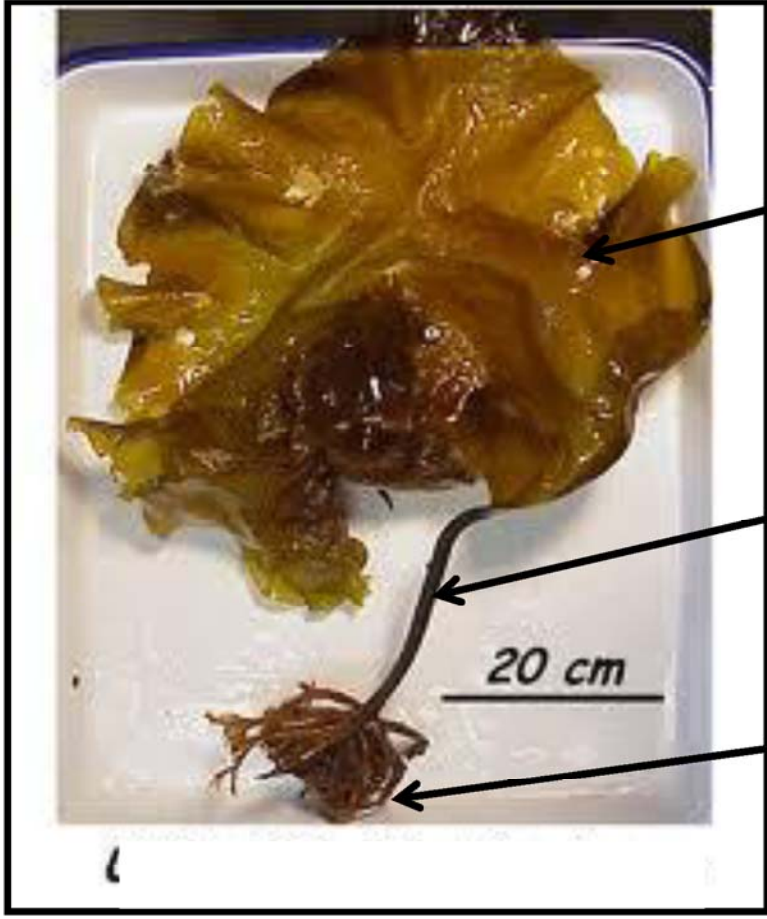
Phaeophyceae

General Characters

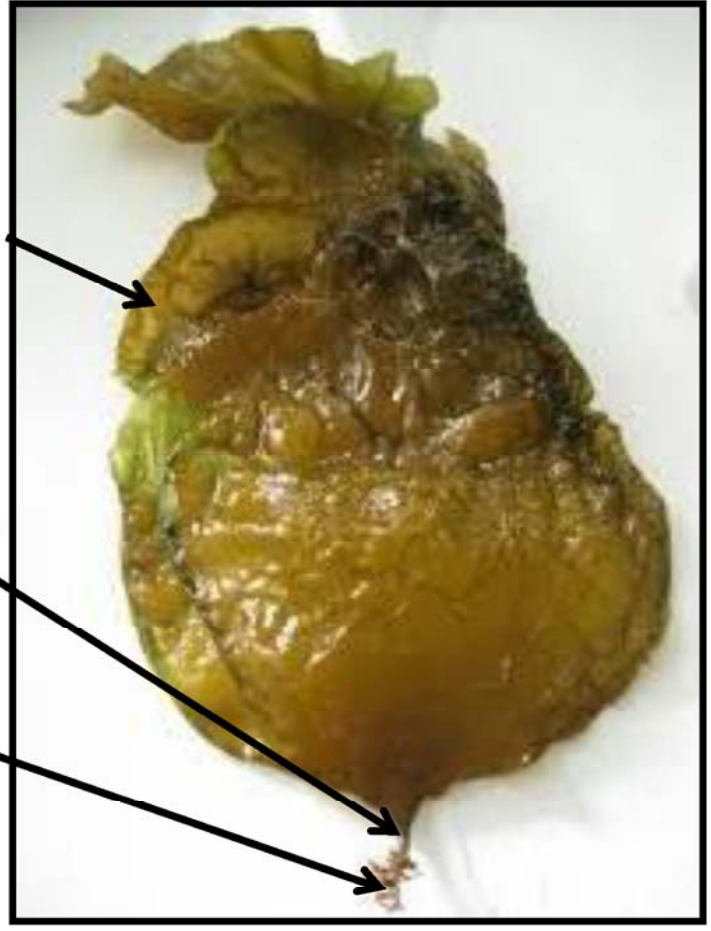
- **1,500 species of seaweeds that are brown to olive green in color.**
- **Many brown algae are relatively large, one giant kelp measured 274 meters in length—a length believed to be a record for any single living organism, none are unicellular or colonial forms.**

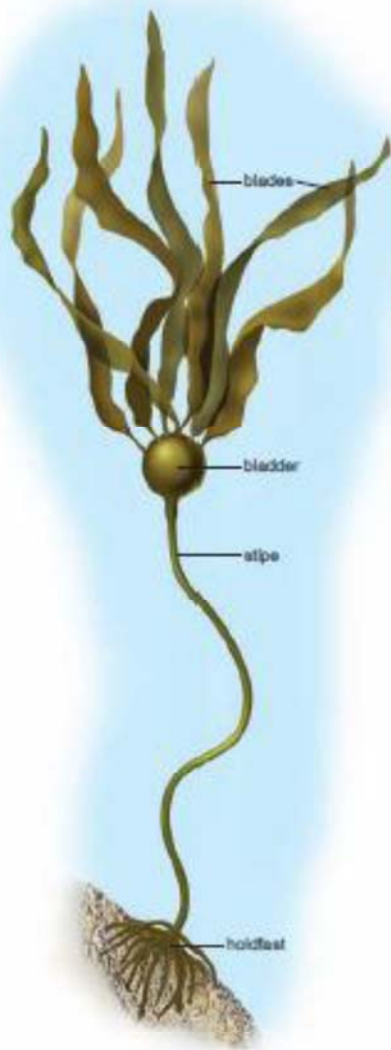
- **Occurrence:** Only 6 of the 265 known genera occur in fresh water; the vast majority grows in colder ocean waters, usually in shallower areas, although the giant kelp (*Macrocystis pyrifera*) may be found in water up to 30 meters or more deep, and one brown alga (*Lobophora variegata*) was seen in clear tropical waters growing at a depth of 220 meters.

- **Vegetative structure:** Many of the brown algae have a thallus (plural: thalli, the term for multicellular bodies that are usually flattened and not organized into leaves, stems, and roots)
- They are differentiated into holdfast, stipe, and flattened, leaflike blades.



Blade
Stipe
Holdfast





- **The blades and most of the body are photosynthetic and may have gas-filled floats called bladders toward their bases.**

The bladder gases may include as much as 10% by volume of carbon monoxide. The function of the carbon monoxide, which is deadly to animal life, is not known.



Brown Algal Forms

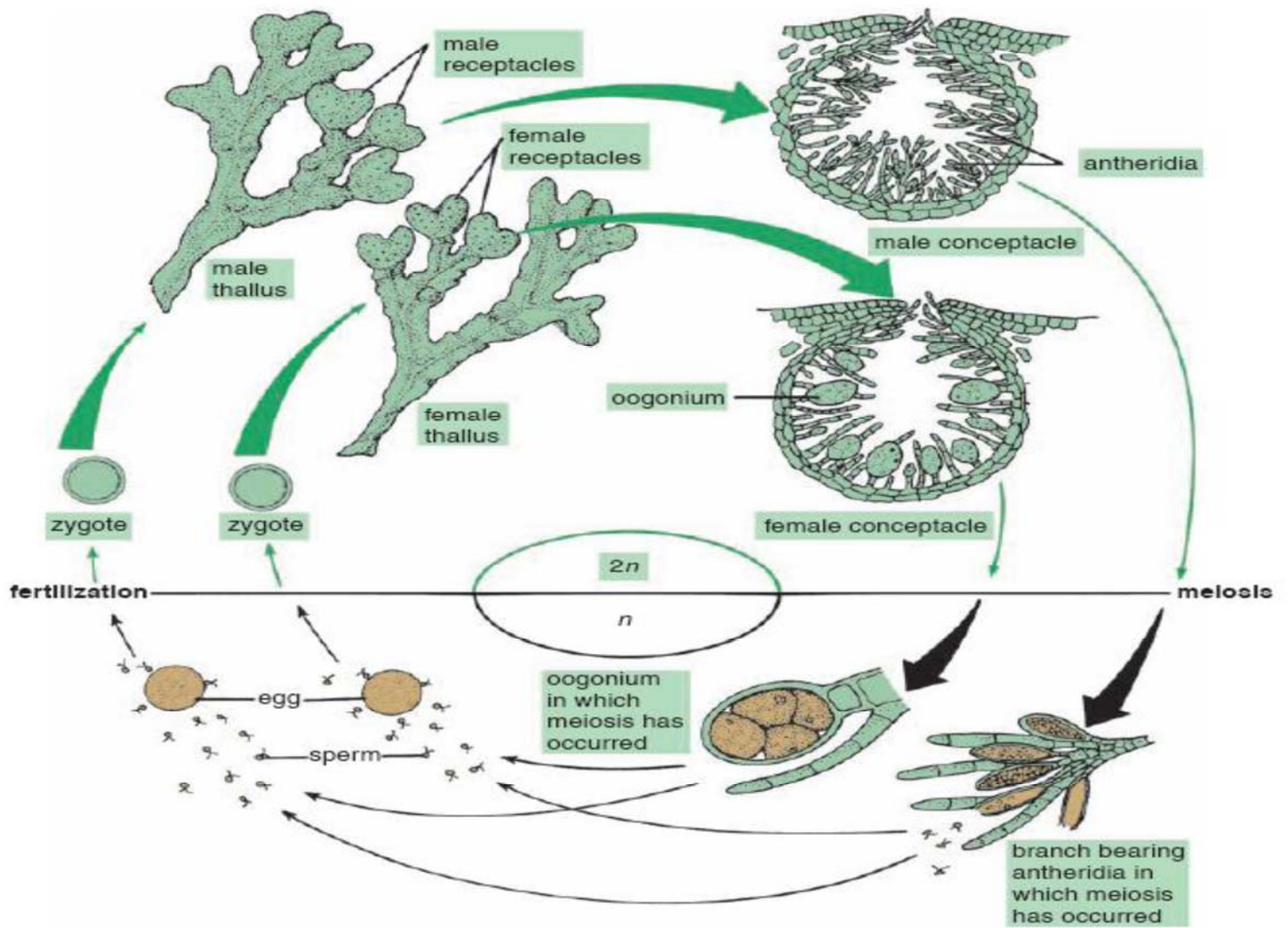
Air Bladders



- **The color of brown algae can vary from light yellow brown to almost black, reflecting the presence of varying amounts of the brown pigment fucoxanthin, in addition to chlorophylls a and c and several other pigments in the chloroplasts.**

- **The main food reserve is a carbohydrate. known as laminarin.**
- **Algin, or alginic acid occurs on or in the cell walls and can represent as much as 40% of the dry weight of some kelps.**

- **The only motile cells in the brown algae are the reproductive cells.**
- **Brown algae reproduce asexually by fragmentation, while some produce autospores.**
- **Sexual reproduction takes several different forms, depending on the species. The phases of the life cycles are usually diploid.**



Life cycle of the common rockweed *Fucus*.

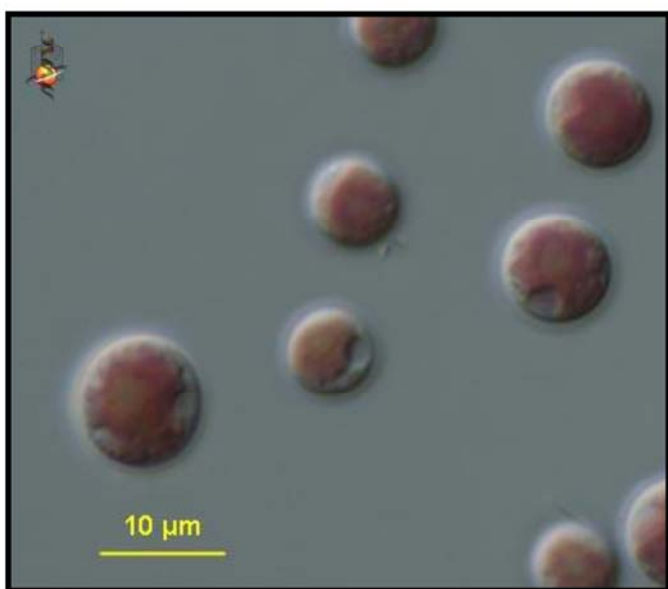
Rhodophyceae

General Characters

- **Vegetative structure:** Most of the more than 5,000 species of red algae are seaweeds.

A few are unicellular, but most are filamentous.

- **Occurrence:** in warmer and deeper waters. Some grow attached to rocks in intertidal zones, where they may be exposed at low tide. Others grow at depths of up to 200 meter



Unicellular



Filamentous



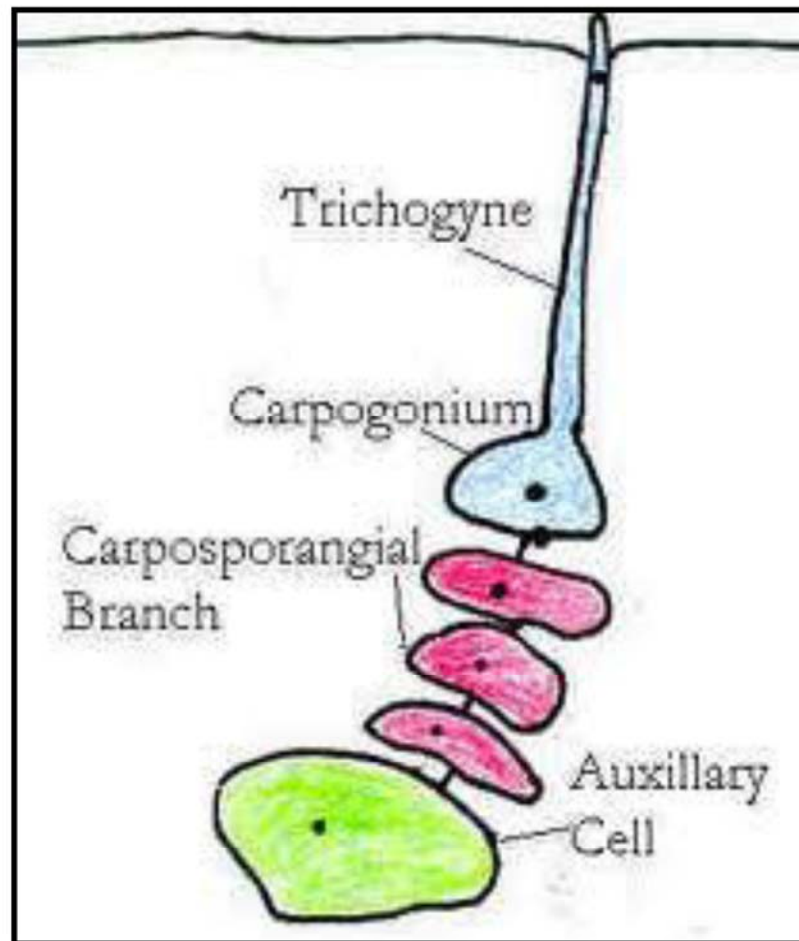
Multicellular

- **Pigments, including chlorophyll a and sometimes chlorophyll d, are also present in the chloroplasts. The red to purplish colors of most red algae are due to the presence of varying amounts of red and blue accessory pigments called phycobilins (phycocyanin and phycoerythrin).**

- **The principal reserve food is a carbohydrate called floridean starch.**
- **A number of red algae also produce agar and carrageenan which are used as solidifying agent in bacteriological media and thickening material respectively.**

- **The red algae have relatively complex life cycles, often involving three different types of thallus structures (gametophyte, carposporophyte and tetrasporophyte).**
- **All of the reproductive cells are non-motile and are carried passively by water currents.**

- **The female sex structures, called carpogonia, are produced on the female gametophyte thallus. Each carpogonium consists of a single cell that looks something like a microscopic bottle with a long neck called a trichogyne. A single nucleus at the base of the carpogonium functions as the female gamete, or egg.**



Structure of mature carpogonium